

# Damage Adaptive Guidance for Piloted Upset Recovery, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)



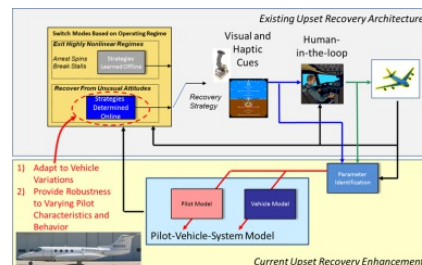
## ABSTRACT

Aircraft Loss-Of-Control (LOC) has been a longstanding contributor to fatal aviation accidents. Inappropriate pilot action for healthy aircraft, control failures, and vehicle impairment are frequent contributors to LOC accidents. These accidents could be reduced if an on-board system was available to immediately guide the pilot to a safe flight condition (including cases of control failure or vehicle impairment). Barron Associates previously developed and demonstrated (in pilot-in-the-loop simulations) a system for finding appropriate control input sequences for upset recovery, and for cueing pilots to follow these sequences. The proposed work adds several innovative capabilities to the existing architecture and includes flight test verification of the efficacy. One of the most significant current enhancements is the addition of adaptation to address off-nominal vehicle responses. Off-nominal vehicle responses can occur for a number of reasons including adverse onboard conditions (e.g., actuator failures, engine failures, or airframe damage) and external hazards, especially icing. The addition of adaptation capabilities enables the system to provide appropriate upset recovery guidance in cases of off-nominal vehicle response. The recovery guidance system is also specifically designed to be robust to variations in pilot dynamic behavior as well as to provide robustness to pilot deviations from the recommended recovery strategies.

## ANTICIPATED BENEFITS

### To NASA funded missions:

Potential NASA Commercial Applications: One of the overarching goals of the NASA Airspace Operations and Safety Program (AOSP) is to improve aircraft safety as the NextGen Air Transportation System matures. As loss of control accounts for a significant percentage of the fatal accident rate, developing systems that improve the response to upset conditions in flight are critical to achieving this goal. This research addresses three

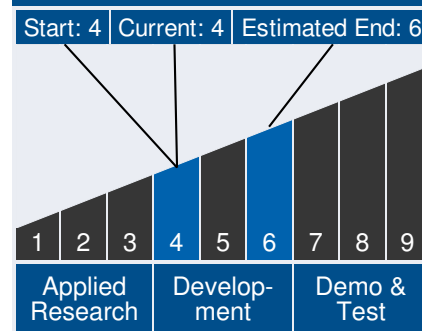


Damage Adaptive Guidance for  
Piloted Upset Recovery

## Table of Contents

Abstract . . . . .	1
Anticipated Benefits . . . . .	1
Technology Maturity . . . . .	1
Management Team . . . . .	1
Technology Areas . . . . .	2
U.S. Work Locations and Key Partners . . . . .	3
Details for Technology 1 . . . . .	4

## Technology Maturity



## Management Team

### Program Executives:

- Joseph Grant
- Laguduva Kubendran

### Program Manager:

- Carlos Torrez

*Continued on following page.*

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of the top challenges for the AOSP including: (1) the Airspace Technology Demonstrations (ATD) Project area of Technologies for Assuring Safe Aircraft Energy and Attitude State (TASEAS), (2) the Real-Time System-Wide Safety Assurance (RSSA) area of "reducing flight risk in areas of attitude and energy aircraft state awareness", and (3), with direct application to autonomous recovery, the Safe Autonomous Systems Operation (SASO) Project. The DAGUR system provides robust recoveries for nominal and impaired aircraft as well as robust performance in the face of variations in pilot behavior (Challenges 1 and 2). The provided closed-loop guidance is equally applicable to autonomous vehicle upset recovery (Challenge 3).

## To the commercial space industry:

Potential Non-NASA Commercial Applications: The immediate application for the proposed technology is in the civilian aerospace sector to improve aviation safety and security. However, the technology will readily extend to military aviation and space exploration. The increasing prevalence of autonomous and remotely-piloted UAVs for military and homeland security applications, their consideration for terrestrial science missions and planetary exploration in the near-to-mid term, and the likely ubiquitous commercial roles of these vehicles in the longer-term, provide numerous opportunities for the transition of the proposed SBIR technologies. Application potential is not limited to the aerospace industry, but is extensible to all systems where a human operator can be assisted by an automated agent or where an autonomous system could benefit from an on-board upset recovery solution.

## Management Team (cont.)

### Principal Investigator:

- Nathan Richards

## Technology Areas

### Primary Technology Area:

Aeronautics (TA 15)

- └ Safe, Efficient, Growth in Global Aviation (TA 15.1)
  - └ System-Wide Safety, Predictability, and Reliability through Full NextGen Functionality (TA 15.1.2)
    - └ Reduce Occurrences of Crew Loss of Aircraft State Awareness (TA 15.1.2.1)

### Secondary Technology Area:

Human Exploration Destination Systems (TA 7)

- └ Mission Operations and Safety (TA 7.5)
  - └ Integrated Flight Operations Systems (TA 7.5.3)

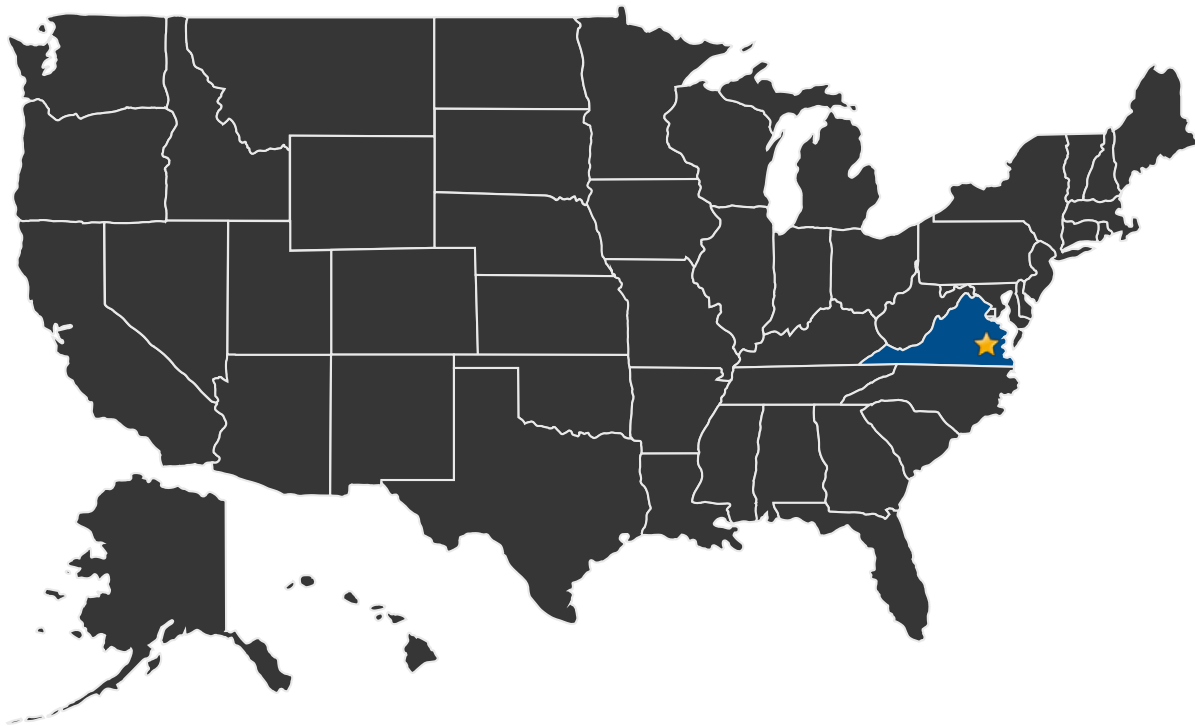
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## U.S. WORK LOCATIONS AND KEY PARTNERS

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■ U.S. States With Work      ★ **Lead Center:**  
Langley Research Center

### Other Organizations Performing Work:

- Barron Associates, Inc. (Charlottesville, VA)

## PROJECT LIBRARY

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### Presentations

- Briefing Chart
  - (<http://techport.nasa.gov:80/file/18093>)

Active Project (2015 - 2017)

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## DETAILS FOR TECHNOLOGY 1

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### Technology Title

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